DEVELOPING A HEURISTIC TO IMPROVE FLEET UTILIZATION THROUGH BACKHAULS

Submitted By: Geetika Tahilyani and Shrihari Venkatesh
AHOLD DELHAIZE AND RETAIL BUSINESS SERVICES

• Parent Company: Ahold Delhaize - a world-leading food retailer with 6,700 stores worldwide

• The fourth largest grocery retail group in the United States with more than 1,950 Stores

• RBS is the service company of Ahold Delhaize USA and manages the logistics for Ahold Delhaize Supply Chain Brands:

![](image)

AHOLD DELHAIZE At a Glance

- >700 Suppliers
- 1100 trucks
- >30 DC’s
- $50 million per month on 3rd party deliveries
- >1200 Stores
- 20 million miles driven per month
THE PROBLEM STATEMENT

Transportation from Vendors to Ahold DCs is managed with a combination of contracted fleet and private fleet.

There is a potential to reduce empty backhaul miles of outbound network by using them for inbound transportation.
Methodology for optimization of an integrated backhaul network

Case Study: Food Lion
DATA SOURCES

Data:
• Location of Stores and Existing Outbound Routes
• Delivery and Pick-up Schedule
• Location of CPU Vendors* and existing Backhaul pickups
• Outbound and inbound shipment demand
• Costs with and without backhauls

* - Not all Vendor location coordinates were available
APPROACH: HEURISTIC FOR IDENTIFYING BACKHAUL SOLUTIONS

Step 1: Find the Last Store in Each Route

Step 2: Find the Closest Vendor to Each Store based on Great Circle Distance Formula

Step 3: Calculate the additional miles = Distance Between Store to Vendor + Vendor to DC - Store to DC

Step 4: Convert the additional distance to time (60 Hrs/Mile) and add 2 Hours for Loading at vendor. This is additional time.

Step 5: Add the additional time to current work time (DC-Store-DC) and apply the constraint of total trip time less than 14 Hours

Step 6: Apply the above constraint to find the feasible vendors

Step 7: If the same vendor is feasible for multiple routes, chose the routes with minimum total time

Step 8: If there are X pick ups per vendor per week, then chose fastest X routes for respective vendor

Step 9: Calculate the savings by comparing cost of outsourcing and using backhauls for the selected backhaul options
**Objective Function:** Minimize Total Trip Time

**Variables:** $y_{ij} =$ travel time, $w_{ij} =$ loading time, $x_{ij} =$ binary decision variable, $N =$ number of vendors

**Constraints:**
1. Trip time need to be less than 14 hours
2. Using loading time as 2 hours and driving time as 60 mph
3. Match supply and demand to make sure there are pickups for the backhaul solutions

Where:

\[
\begin{align*}
\text{Min } z &= \sum_{i=1}^{N} \sum_{j=1}^{N} (w_{ij} + y_{ij})x_{ij} \\
\text{Subject to:} & \\
\sum_{i=1}^{N} \sum_{j=1}^{N} (w_{ij} + y_{ij})x_{ij} & \leq T \\
x_{ij} & \in (0,1) \forall i,j
\end{align*}
\]
RESULTS: FINANCIAL IMPACT

Based on the analysis of data for Food Lion, we found at least 18 possible backhaul pick-ups based on the current routing.

Implementing backhauls on these 18 routes has a potential of weekly cost savings of $6,051 and annual savings of $320,000 for Food Lion.

Extrapolating these results for the rest of the company, we determined that Ahold Delhaize could save up to $1.6 million from this backhaul heuristic.

18 Possible Backhaul Routes for Food Lion

Saving of $6,000 per week for Food Lion

Annual Saving Food Lion: $320K

Annual Saving All Entities: $1.6 Million
RESULTS: ENVIRONMENTAL IMPACT

Adding backhauls reduces the total distance traveled by vehicles used for outbound and inbound shipments and also reduces CO$_2$ emissions.

The reduction in CO$_2$ emissions for Food Lion are 3,208 pounds per week, which is a reduction of 166,800 pounds annually.

Extrapolating these results to the other brands, Ahold Delhaize could reduce their carbon footprint by 830,000 pounds per year. This is equivalent to:

Source: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator
# Sensitivity Analysis for Food Lion

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Change</th>
<th>New Value</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Case</td>
<td></td>
<td></td>
<td>$320,000</td>
</tr>
<tr>
<td>Increase in Cost of Backhaul</td>
<td>20%</td>
<td>$3.6/Mile</td>
<td>$200,194</td>
</tr>
<tr>
<td>Decrease in Cost of Outsourcing</td>
<td>20%</td>
<td>$4/Mile</td>
<td>$137,979</td>
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<tr>
<td>Combination of 1 and 2</td>
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<td>Both 1 &amp; 2 above</td>
<td>$24,000</td>
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<tr>
<td>Increase in loading time at the vendor</td>
<td>50%</td>
<td>3 Hours</td>
<td>$315,000</td>
</tr>
<tr>
<td>Increase in total trip time</td>
<td></td>
<td>+ 2 Hours</td>
<td>$264,000</td>
</tr>
<tr>
<td>Increase in cost of outsourcing</td>
<td>10%</td>
<td>$5.5/Mile</td>
<td>$400,000</td>
</tr>
</tbody>
</table>

Base Case: Cost of Backhaul-$3/Mile, Cost of Outsourcing- $5/Mile, Loading time at vendor- 2 Hours
50% of the feasible routes have three stops and 33% have four stops. In order to maximize backhauls and fleet utilization, routes should be planned with fewer stops (around three or four) to enable trucks to also complete backhauls.

This analysis is helpful in prioritizing backhauls since the routes with larger time buffers should be prioritized since they have more flexibility and can more easily accommodate delays in loading or traffic and still make it back to the DC within 14 hours.
PATH FORWARD

Our recommendations to Ahold Delhaize are as follows:

- Analyze the other operating brands in Ahold Delhaize
- For each banner, identify practical solutions based on the trip durations and their sensitivity to increases in loading time and decreases in driving speed
- Establish a group to review which routes they are going to implement and how to monitor operations
- If the operating entities are able to share assets and no longer operate in silos, this entire exercise can be repeated using the entire network and fleet of Ahold Delhaize
LIMITATIONS

The heuristic does not consider the following constraints:

1. DC Operating Hours
2. Vendor Pick-Up times
3. Limitations capacity of the outbound fleet to adapt to changes in increase in trip time due to backhauls
Key Considerations for Implementation

- The number of feasible backhauls will depend on the transportation network and the proximity of stores to suppliers and DC’s.
- For cases where the network is spread over a larger region, we expect fewer solutions and vice versa for denser networks.
- Impact of operational constraints across banners due to the difference between unionized and non-unionized fleets.
- Variability of demand and deliveries throughout the year: Due to changes in demand over the course of the year, some vendors might not have enough pickups to satisfy the backhaul solutions assigned to them.
- If there are weeks when the vendors do not have enough pickups for the backhauls, then the heuristic needs to be repeated to identify another backhaul opportunity.
FORMULAE & ASSUMPTIONS

For Financial Impact:

\[ \text{Savings} = \text{Cost of Outsourcing} \times \text{Distance from Vendor to DC} - \text{Cost of Backhaul} \times \text{Extra Miles} \]

Cost of Outsourcing = $5/Mile

Cost of Backhaul = $3/Mile

For Environmental Impact:

\[ \text{Total Emissions} = \text{Emission Factor} \times \text{Distance} \times [\text{Fuel Consumption (empty trailer)} + \left(\text{Fuel Consumption (full trailer)} - \text{Fuel Consumption (empty trailer)}\right) \times \text{Load Factor}] \]

Where,

<table>
<thead>
<tr>
<th>CO2 Emission Factor</th>
<th>2621</th>
<th>Gm/Ltr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Consumption (empty trailer)</td>
<td>0.288</td>
<td>ltr/km</td>
</tr>
<tr>
<td>Fuel Consumption (full trailer)</td>
<td>0.504</td>
<td>ltr/km</td>
</tr>
<tr>
<td>Load Factor for Full Truck Load transportation</td>
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<td></td>
</tr>
</tbody>
</table>

MIT Supply Chain Management